8.0 SUMMARY OF HUMAN HEALTH RISK ASSESSMENT

This section presents a summary of the various human health risk assessments conducted for Sauget Area 1. Section 8.1 presents a summary of the documents, Section 8.2 presents a summary of the conceptual site model based on all of the documents, and Section 8.3 presents a summary of the risk assessment results and conclusions based on all of the documents.

8.1 Summary of Risk Assessment Documents

Human health risk assessment (HHRA) activities have been ongoing at Sauget Area 1 for a number of years. The following provides a brief description of the various documents. Note that the consulting firm ENSR became AECOM on November 10, 2008. Documents submitted prior to that date are cited as ENSR, while documents submitted after that date are cited as AECOM.

Site-Wide HHRA. A site-wide human health risk assessment (site-wide HHRA) was conducted for the Sauget Area 1 Sites (G, H, I, L, N) and seven residential transects (Transects 1-7) in 2001 (ENSR, 2001). Site M was not included in the HHRA because it was subject to remediation (see below). The site-wide HHRA also evaluated portions of Dead Creek Segment F not subject to remediation (see below) and the Borrow Pit Lake. The HHRA was approved by USEPA on November 13, 2001.

Dead Creek Bottom Soils HHRA. A Supplemental Unilateral Administrative Order (UAO) was issued on May 30, 2000 that required removal of sediment from Dead Creek Segments B, C, D, E, a portion of Creek Segment F, and Site M to address ecological risk and potential flooding concerns. Confirmation samples were collected and evaluated in the Dead Creek Bottom Soils HHRA (CBS HHRA, ENSR, 2006). The Dead Creek Bottom Soils HHRA was approved by USEPA on September 18, 2012.

Vapor Intrusion HHRA. The site-wide HHRA (ENSR, 2001) included an evaluation of potential risks to an indoor worker based on volatilization of constituents in groundwater to indoor air of an overlying hypothetical building. Due to the evolving science of vapor intrusion, the vapor intrusion evaluation was updated using a tiered approach and soil gas data collected in November 2006, in a technical memorandum in 2008-2009, referred to as the Vapor Intrusion HHRA (VI HHRA, AECOM, 2009a). USEPA submitted comments on a previous version of this document, and a second memorandum was submitted outlining chemical usage in the Wiese Building (AECOM, 2009b). In August 2009, the Wiese memorandum was approved by USEPA and the VI HHRA (AECOM, 2009a) was revised and re-submitted, including the Wiese memorandum as Attachment E. The VI HHRA was approved by USEPA on September 30, 2009.

Utility Corridor HHRA. An investigation of existing utility lines that are in or adjacent to the sites was conducted in 2007-2008. The results of that investigation (Solutia, 2007, Section 4.0 revised 2008) indicated that the one utility that is located within a waste disposal area is a water supply line that runs through Site I to the Sauget Village Hall. All of the other utility lines are either overhead

power lines or underground lines that are outside of the limits of waste placement. The one water supply line running through Site I will be relocated outside of the waste boundary.

The only other utility lines where utility workers could potentially be exposed to wastes are those running along Queeny Avenue between Sites H and I. Review of historical aerial photographs show that these two areas were connected prior to approximately 1949 or 1950. At that time, Queeny Avenue was relocated southwards from what is now the Cerro Flow Products facility to its present position. Although the boundary test trench excavated in this area demonstrated that the waste stops well short of Queeny Avenue, it was unclear if all of the waste under the new road alignment was removed prior to building the road. Accordingly, the Sampling Plan for Utility Corridor Investigations (Solutia, 2007; Section 4.0 revised 2008) proposed an investigation to address that question. Data collected during the investigation were evaluated in the Utility Corridor HHRA (ENSR, 2008) which was approved by USEPA on September 10, 2008. The results of the Utility Corridor Investigation and HHRA indicated waste between Sites H and I (ENSR, 2008). In addition, the Utility Corridor HHRA concluded that the total potential risk for a utility worker exceeds USEPA's target risk range of 10^{-6} to 10^{-4} under the RME scenario on the Utility Corridor adjacent to Site H (south of Queeny Avenue). The total potential risk for a utility worker adjacent to Site I was within the target range of 10^{-6} to 10^{-4} under the RME scenario and was below the range in the MLE scenario. The Utility Corridor HHRA was approved by USEPA on September 10, 2008.

8.2 Conceptual Site Model

To guide identification of appropriate exposure pathways for evaluation in the risk assessment, a Conceptual Site Model (CSM) for human health was developed as part of the scoping activities in the HHRA Workplan (Solutia, 1999). The purpose of the CSM is to identify source areas, potential migration pathways of constituents from source areas to environmental media where exposure can occur, and to identify potential human receptors. The CSM is meant to be a "living" model that can be updated and modified as additional data become available.

The CSM and the selection of exposure pathways has been updated based the various documents noted above. Table 8-1 presents the selection of exposure pathways for the various receptors and areas (the CSM in tabular format) and is based on both the CSM and the selection of Constituents of Potential Concern (COPCs) in each document. The site-wide HHRA presents a detailed discussion of the CSM in Section 5.1 (ENSR, 2001). A summary of the CSM is presented below, combining the information from the documents discussed above. The CSM is presented for the Sites, Dead Creek and the Borrow Pit Area, and the residential transects.

8.2.1 Sites

The Sauget Area 1 Sites (G, H, I, L, N), shown in Figure 1-2, have been used for industrial purposes for many years (since the 1930s or earlier) and use of these areas is expected to remain industrial. The Sites within Sauget Area 1 are zoned commercial/industrial and it is likely that the sites will continue to be used well into the reasonably foreseeable future for commercial/industrial purposes. Therefore, the Sites were evaluated for non-residential use scenarios in the site-wide

HHRA (ENSR, 2001). However, at the request of USEPA, Site N was evaluated for both a nonresidential as well as a hypothetical future residential scenario. There is a residential area located to the east of Sites H and I. However, Sites H and I were not evaluated for an off-site residential exposure scenario because there are no complete exposure pathways for these off-site residents. The HHRA was conducted using validated data collected during 1999-2000 for the Remedial Investigation (RI). These data are summarized in Section 3.0 of this report. In addition, USEPA has requested the evaluation of the potential for exposure to constituents that may be present in air in off-site residential areas that are present in the vicinity of the Sites; the closest area is located to the east of Sites H and I. Potential exposure could occur via inhalation of constituents from the Sites that may be present in air that could be transported to the off-site residential area. An evaluation of this pathway is provided below.

Evaluation of Ambient Air The HHRA included a short-term and chronic screening assessment of 24-hour ambient air sample data collected at Sites G, H, I, and L. This approach and completed evaluation were approved by USEPA in the HHRA Workplan (ENSR, 1999) and the HHRA (ENSR, 2001), respectively. The air samples were not used in the calculation of risks in the HHRA because they were 24-hour air samples collected at a single time point. Downwind air sample concentrations were compared to upwind sample concentrations and to risk-based screening levels based on chronic and subchronic/acute exposure scenarios.

USEPA Region 9 Preliminary Remediation Goals (PRGs) (1999), which were current at the time the HHRA was conducted, were used as the risk-based screening levels for chronic exposure. As discussed in the HHRA, the Massachusetts Department of Environmental Protection's (MADEP) approach for conducting a short-term screening assessment (MADEP, 1995) was used due to the limited available guidance for conducting short-term evaluations. MADEP recommends that the average concentration be compared to 100-times the screening level. Therefore, for the short-term evaluation, the Region 9 PRGs were multiplied by a factor of 100, as discussed in the HHRA. The following table summarizes the compounds that were detected above both the chronic screening levels and upwind concentrations in Areas G, H, I, and L:

	Ambient Air Pathway			
Constituent	**G**	**H**	**I**	**L**
4-Methyl-2-pentanone	X	--	--	--
Acetone	X	--	--	--
Methylene chloride	X	X	X	X
Trichloroethene	--	X	--	--
Cadmium	--	--	X	--
Total:	**3**	**2**	**2**	**1**

X – Constituent detected above screening level and upwind concentration.
-- Constituent not detected above screening level and/or upwind concentration.

Sites G and L are located at a distance from any off-site residential areas. Therefore, ambient air concentrations detected in samples collected in Sites G and L are expected to attenuate before reaching the off-site residential areas. Sites H and I are located closer to the off-site residential areas. At Site H, methylene chloride and trichloroethene were detected in one of the two ambient

air samples at concentrations above risk-based screening levels based on a $1x10^{-6}$ risk level. Neither of these compounds was detected in the other air sample. However, the detected air concentrations of both of these compounds are below the screening level based on a $1x10^{-5}$ risk level. Therefore, the potential risk posed to residential receptor from ambient air concentrations of constituents in Site H are within USEPA's target risk range of $1x10^{-6}$ to $1x10^{-4}$. In addition, in the HHRA, an on-site outdoor worker at Site H was evaluated for potential exposure to COPCs that may be suspended as dusts from site soils (no volatile COPCs were identified in site soils). The outdoor air exposure point concentrations estimated in the HHRA based on soil concentrations for evaluation of this pathway are lower than the Region 9 PRGs for ambient air (1999) based on a $1x10^{-6}$ risk level. Therefore, the potential risk posed to on-site and off-site residents via inhalation of constituents in outdoor air that originated from soil at Site H are below USEPA's target risk range of $1x10^{-6}$ to $1x10^{-4}$.

At Site I, methylene chloride was detected in both air samples above risk-based screening levels based on a $1x10^{-6}$ risk level. However, the methylene chloride concentration in one of the air samples was detected below the associated upgradient air concentration at a much lower concentration. In addition, methylene chloride was not identified as a COPC in soil or groundwater. Therefore, laboratory contamination is the most likely source of the methylene chloride in the Site I air samples, as methylene chloride is known as a common laboratory contaminant. In addition, in the HHRA, an on-site outdoor worker at Site I was evaluated for potential exposure to COPCs that may be suspended as dusts from soils (no volatile COPCs were identified in site soils). The outdoor air exposure point concentrations estimated in the HHRA based on soil concentrations for evaluation of this pathway are lower than the Region 9 PRGs for ambient air (1999) based on a $1x10^{-6}$ risk level. Therefore, the potential risk posed to on-site and off-site residents via inhalation of constituents in outdoor air that originated from soil at Site I are below USEPA's target risk range of $1x10^{-6}$ to $1x10^{-4}$.

Cadmium was also detected in ambient air at a concentration above the risk-based screening level at Site I in one of the two air samples, but not the other. Although the detected cadmium concentration was above the risk-based screening level associated with a $1x10^{-6}$ risk level, the detected concentration is below the screening level based on a $1x10^{-4}$ risk level. Therefore, the potential risk posed to a residential receptor from ambient air concentrations of cadmium within Site I is within USEPA's target risk range of $1x10^{-6}$ to $1x10^{-4}$.

The results of the short-term evaluation showed that there were no constituents exceeding subchronic screening levels in Site H. Methylene chloride was the only compound with an arithmetic mean concentration above the subchronic screening level in Site I. However, as discussed for the chronic evaluation, it is believed that methylene chloride concentrations are due to laboratory contamination. In addition, it is expected that ambient air concentrations for all detected constituents in the off-site residential area would be lower than those measured on Sites H and I.

Based on the above discussion of ambient air, the potential risk and HI posed to on-site and off-site residents via inhalation of constituents in outdoor air at Sites H and I are below or within USEPA's target risk range of $1x10^{-6}$ to $1x10^{-4}$. Therefore, no COCs are identified in ambient air.

Receptors were identified for the sites based on the CSM and the COPCs identified in media in the Sites. COPCs were identified in soils, leachate, and groundwater in Sites G, H, I, and L. COPCs were identified in Site N surface soil for the residential scenario only.

A **resident receptor** was evaluated in the site-wide HHRA (ENSR, 2001) for potential exposure to COPCs in surface soils via incidental ingestion and dermal contact, and via inhalation of COPCs that may be suspended as dusts from soils in Site N. Inspection of the area indicated that some residences have vegetable gardens. As COPCs may be taken up by plant material and subsequently ingested, a produce consumption pathway was included in the HHRA; however, COPCs for this pathway were not identified in Site N.

An **on-site outdoor industrial worker** and a **trespassing teenager** were evaluated in the site-wide HHRA (ENSR, 2001) for potential exposure to COPCs in surface soil via incidental ingestion and dermal contact, and via inhalation of COPCs that may be suspended as dusts from soils (no volatile COPCs were identified in site soils) and to COPCs that may volatilize into outdoor air from underlying groundwater.

An **on-site construction/utility worker** was evaluated in the site-wide HHRA (ENSR, 2001) for potential exposure to COPCs in surface and subsurface soil via incidental ingestion and dermal contact, and via inhalation of particulates suspended during excavation activity. Construction/utility work is assumed to occur up to depths of 30 feet below ground surface (bgs). Due to the shallow depth of groundwater, the construction/utility worker may contact groundwater or leachate during excavation. Therefore, the construction worker is assumed to be exposed to COPCs in groundwater and leachate via incidental ingestion and dermal contact, and via inhalation of COPCs volatilized from standing water in an excavation trench. Because the sites are areas of known waste disposal, it is assumed that appropriate safeguards are used when excavating in waste areas (gas monitoring, appropriate personal protective equipment).

Data used in the construction worker scenario include the surface soil and groundwater data summarized in Section 3.0 of this report and historical data for subsurface soil and leachate. Subsurface samples collected in the Sites in support of the RI were analyzed using toxicity characteristic leaching procedure (TCLP), not total constituent concentrations. Therefore, historical data collected for other investigations were employed to evaluate potential construction worker contact with COPCs in the subsurface. These data were obtained from the following: Sauget Area 1 Data Tables/Maps, Ecology and Environmental, Inc., February 1998, prepared for USEPA Region 5 Office of Superfund, Chicago, IL, ARCS Contract No. 68-W8-0086, Work Assignment No. 47-5N60. The historical data are unvalidated, and detection limits were not available for the majority of results reported as not detected. TCLP data from subsurface samples collected in the sites were used to represent leachate concentrations, i.e., concentrations in groundwater within the fill material. Additionally, one leachate sample collected from Site G on April 26, 2000 and one leachate sample collected from Site I on April 25, 2000 were used in this evaluation. This evaluation is separate from, and in addition to, the evaluation of the construction worker receptor's exposure to groundwater using data collected during the RI.

Due to the presence of volatiles in the subsurface of the Sites, an **on-site indoor industrial worker** was evaluated in the VI HHRA (AECOM, 2009a) for potential exposure to COPCs via inhalation of volatile constituents present in indoor air due to vapor intrusion based on a tiered evaluation. The Sauget Village Hall adjacent to Site I, the Cerro Guard House in Site I, the Cerro Control Center west of Site I, and the Weise building west of Site G were included in the evaluation. These buildings are shown in Figure 4-6. Soil gas data collected in November and December 2006 and summarized in Section 4.4 were used in the VI HHRA. It is unlikely that the indoor worker receptor would be exposed to soils to the same extent as an outdoor worker, therefore, this pathway was concluded to be insignificant and was not quantitatively evaluated in the risk assessment for the indoor worker.

Due to the potential presence of waste materials in the utility corridor that runs along Queeny Avenue adjacent to Sites H and I, shown in Figure 4-7, a **utility worker** was evaluated for potential exposure to COPCs in soils and wastes via incidental ingestion and dermal contact, and inhalation of particulates and volatiles suspended during excavation activity in the Utility Corridor HHRA (ENSR, 2008). The data used in this evaluation were collected in June 2007 and are summarized in Section 4.5. The area where wastes may extend into the utility corridor is currently underneath pavement (Queeny Avenue). The pavement prevents direct-contact with materials that may be present. However, due to the presence of utility lines in the area, it is possible that at some point in the future, utility work will require excavation in this area. The existing utility adjacent to Site H is an Explorer Pipeline, which is a 14-inch diameter pipe at a depth of 3 1/2 feet bgs. The existing utility line along Site I is a 4-inch steel line gas line at a depth of 2 1/2 feet bgs. Therefore, there is a potential for human contact (utility worker) with the soils via incidental ingestion, dermal contact, and inhalation. Contact with groundwater is not expected because the depth to groundwater is about 7 feet deeper than the depth of the utilities. Groundwater levels were measured on March 27, 2008 in nearby wells (Judith Lane Containment Cell monitoring wells), as indicated below:

- TCMW-2 had a groundwater level at 10.36 ft bgs
- TCMW-3S had a groundwater level at 11.26 ft bgs
- TCMW-3M had a groundwater level at 11.26 ft bgs

The wells are measured from the top of the casing and each well has a three foot stick up. The groundwater levels were adjusted to ground surface using the available survey data. Groundwater was not encountered during sampling, which confirms the assumption that groundwater would not be contacted during future utility work.

Table 8-1 presents a summary of the exposure pathway selection for each receptor and Site.

8.2.2 Dead Creek, Site M, and Borrow Pit Lake

The Borrow Pit Lake is located on private property, and access is uncontrolled. Recreational fishing may occur in Borrow Pit Lake. Borrow Pit Lake and the majority of Creek Segment F that were not included in the sediment removal action conducted in 2000-2001 were evaluated as one area in the site-wide HHRA (ENSR, 2001). These areas are indicated on Figure 1-3.

COPCs were identified in sediment but not in surface water. Therefore, a **recreational receptor** (i.e., teenager) could be exposed to COPCs in sediment of Creek Segment F and the Borrow Pit Lake while wading or swimming. This scenario was evaluated in the site-wide HHRA (ENSR, 2001).

One COPC was identified in fish tissue collected from Borrow Pit Lake. Therefore, a **recreational fisher receptor** potentially exposed to COPCs in sediment while wading and via ingestion of fish was evaluated in the site-wide HHRA (ENSR, 2001).

Creek bottom soils in Site M and Creek Segments B through F were collected and analyzed after the UAO sediment removal action conducted in 2000-2001 was complete; these areas are indicated on Figure 1-3. Data were collected between October 2001 and February 2002 and are summarized in Section 2.3.2. These data were evaluated in the Creek Bottom Soils HHRA (ENSR, 2006). COPCs were identified in creek bottom soil in Creek Segments B, D, E, F, and Site M.

Access to Dead Creek is generally uncontrolled except for Creek Segment B, which is secured with a fence. As sediment was removed from Site M, it was backfilled with soil from an adjoining property, regraded to drain to Creek Segment B, vegetated and surrounded by a fence. Therefore, a recreational receptor (i.e., child or teenager) could be exposed to COPCs in creek bottom soil of Creek Segment B through Creek Segment F. Given that access to Site M is limited, it is unlikely that any recreational receptor would gain access. However, it was assumed that a recreational teenager could climb the fence and could be exposed to creek bottom soils in Site M. It was assumed that a recreational child could not access Site M. Due to the presence of underground utility lines in several of the Creek Segments, it is possible that excavation work may occur in the future. Therefore, a construction worker receptor could be exposed to COPCs in creek bottom soil of Site M, and Creek Segment B through Creek Segment F during excavation.

Table 8-1 presents a summary of the exposure pathway selection for each receptor and area.

8.2.3 Transect Areas

Floodplain soil samples were collected from the residential transects and were used to evaluate the residential transect areas in the site-wide HHRA (ENSR, 2001); these data are summarized in Section 3.0. The transect areas, which are shown in Figure 3-10, consist of residential, commercial and undeveloped land. Therefore, both residential and non-residential exposure scenarios were evaluated for these areas in the site-wide HHRA (ENSR, 2001). COPCs for a residential scenario were identified in surface soil in Transects 3 through 7 and Site N. COPCs for an industrial scenario were identified in surface soil in Transects 3, 4, 6, and 7, and in subsurface soil in

Transects 4 and 6. The only COPC identified in groundwater in the transect area was lead in a non-potable use well (DW-MCDO), closest to Transect 1.

An **outdoor industrial worker** was evaluated in the site-wide HHRA (ENSR, 2001) for potential exposure to COPCs in surface soil via incidental ingestion and dermal contact, and via inhalation of COPCs that may be suspended as dusts from soils.

A **construction worker receptor** was evaluated in the site-wide HHRA (ENSR, 2001) for potential exposure to COPCs in surface and subsurface soil via incidental ingestion and dermal contact, and via inhalation of particulates suspended during excavation activity. Construction/utility work is assumed to occur up to depths of 30 feet bgs. Due to the shallow depth of groundwater, the construction/utility worker may contact groundwater during excavation. Therefore, the construction worker was assumed to be exposed to COPCs in groundwater via incidental ingestion and dermal contact with standing water in an excavation trench. Volatile inhalation was not included as no volatiles were identified as COPCs in soil groundwater in the transect area. As noted previously, lead was the only COPC identified in groundwater, in well DW-MCDO, closest to Transect 1.

A **resident receptor** was evaluated in the site-wide HHRA (ENSR, 2001) for potential exposure to COPCs in surface soils via incidental ingestion and dermal contact, and via inhalation of COPCs that may be suspended as dusts from soils (volatile inhalation was not included as no volatile COPCs were identified). Inspection of the area indicated that some residences have vegetable gardens. As COPCs may be taken up by plant material and subsequently ingested, a produce consumption pathway was included in the HHRA. A trespassing teenager receptor was not evaluated in the transects and Site N due to the inclusion of the residential scenario in these areas; the residential scenario provides a more conservative evaluation.

Groundwater is not used as a source of drinking water in the area. However, there are some private wells in the area that may be used for outdoor household activities. As shown on Figure 2-27, none of the residential wells are located within the Sauget Area 1 plumes. As noted above, a single COPC, lead, was identified in a non-potable use well near Transect 1. Therefore, potential exposure to groundwater via incidental ingestion and dermal contact during outdoor use of water from a well was evaluated in the site-wide HHRA (ENSR, 2001).

Table 8-1 presents a summary of the exposure pathway selection for each receptor and transect.

8.3 Summary of Risk Assessment Results and Conclusions

A summary of the results and conclusions of the HHRA for each area is presented below. Total potential risks and hazards for each receptor are presented by area in the following tables:

- Table 8-2 total potential carcinogenic risks for each site and receptor;
- Table 8-3 total potential hazard index for each site and receptor;
- Table 8-4 total potential carcinogenic risks for each transect and receptor;

- Table 8-5 total potential hazard index for each transect and receptor;
- Table 8-6 total potential carcinogenic risks for Dead Creek, Borrow Pit Lake, and Site M and each receptor;
- Table 8-7 total potential hazard index for Dead Creek, Borrow Pit Lake, and Site M and each receptor.

Table 8-8 presents a summary of the potential cancer and non-cancer risks for the COCs for both the RME and MLE scenarios. Remedial Goal Options (RGOs) were derived for several receptor scenarios. RGOs were not derived for the construction worker scenario. In most cases, there are several COCs identified for the construction worker scenario in a variety of media and for a number of pathways. RGOs should take into account total risk from all constituents, media, and pathways; therefore, there are a range of RGOs that can be calculated where more than one COC has been identified. This is complicated even further when more than one COC has been identified for more than one toxic endpoint in more than one medium, as is the case here. Furthermore, institutional controls rather than numerical RGOs may be more applicable to the construction worker scenario. Therefore, specific RGOs have not been calculated for the construction worker scenario. However, construction worker COCs should be considered when making remedial decisions.

8.3.1 Sites

Potential risks and hazards for the sites were evaluated in the site-wide HHRA (ENSR, 2001). Potential vapor intrusion risks were evaluated in the Vapor Intrusion HHRA (AECOM, 2009a). The utility corridor between Sites H and I was evaluated in the Utility Corridor HHRA (ENSR, 2008). The results for each site are summarized below and in Tables 8-2 and 8-3. COPCs causing an exceedance of the USEPA target risk range of 10^{-4} to 10^{-6} or a hazard index of one on a toxic endpoint basis are identified as Constituents of Concern (COC) and are presented on Table 8-8.

8.3.1.1 Site G

As shown in Table 8-2, all potential risks calculated for both the RME and MLE receptor scenarios in Site G are within or below the USEPA target risk range of 10^{-4} to 10^{-6}. However, due to uncertainties related to the vapor intrusion pathway, USEPA requested additional information regarding chemical use at buildings where potential risks exceeded 10^{-5}. Therefore, a memorandum was submitted to USEPA outlining chemical usage at the Wiese Building (AECOM, 2009b). USEPA indicated that if hazardous vapor forming chemicals with risk properties similar or higher than site-related COCs contributing to vapor risk are being used as part of routine operations, the existing HHRA VI analysis (ENSR, 2008a) is sufficient because USEPA expects that the contribution from subsurface vapor intrusion to the indoor air concentrations is unlikely to be distinguishable from workplace-related vapors, which are already regulated by other entities. The information supplied to USEPA in the memorandum indicated that similar chemicals to those constituting to the potential carcinogenic risk are being used in the Wiese Building.

As shown in Table 8-3, all potential HIs calculated for both the RME and MLE receptor scenarios for Site G are below the target HI of 1, with the exception of the RME (50.2) and MLE (5.74) construction worker.

Because these HIs were calculated by summing all HIs for all pathways, a toxic endpoint analysis was conducted for the construction worker in Appendix R of the site-wide HHRA (ENSR, 2001). Based on the toxic endpoint analyses, benzene, chlorobenzene, naphthalene, phosphorus, and Polychlorinated Biphenyls (PCBs) are identified as COCs for the construction worker.

Table 8-8 presents a summary of the potential cancer and non-cancer risks for the COCs for both the RME and MLE scenarios.

Site G Conclusions

Based on the results of the site-wide HHRA (ENSR, 2001), the following COCs have been identified for the construction worker in Site G:

- Benzene (inhalation of excavation air from groundwater and leachate)
- Chlorobenzene (inhalation of excavation air from leachate)
- Naphthalene (inhalation of excavation air from groundwater and leachate)
- Phosphorus (ingestion and dermal contact with subsurface soil)
- PCBs (ingestion and dermal contact with subsurface soil)

As noted previously, RGOs were not developed for the construction worker scenario. Table 8-8 presents a summary of the potential cancer and non-cancer risks for the above listed COCs.

8.3.1.2 Site H

As shown in Table 8-2, all potential risks calculated for both the RME and MLE receptor scenarios in Site H are within or below the USEPA target risk range of 10^{-4} to 10^{-6}, with the exception of the RME ($1.58x10^{-2}$) and MLE ($4.61x10^{-4}$) utility worker. Potential risks are driven by ingestion and dermal contact with 2,3,7,8-TCDD-TEQ, 4,4-DDD, 4,4-DDT, and dieldrin which are therefore identified as COCs.

As shown in Table 8-3, all potential HIs calculated for both the RME and MLE receptor scenarios for Site H are below the target HI of 1, with the exception of the following (HIs are noted):

- The RME(167) and MLE (10.4) construction worker
- The RME (628) and MLE (66.3) utility worker

Because these HIs were calculated by summing all HIs for all pathways, a toxic endpoint analysis was conducted for the construction worker in Appendix R of the site-wide HHRA (ENSR, 2001) and

in Table 6-1 of the Utility Corridor HHRA (ESNR, 2008). Based on the toxic endpoint analyses, the following constituents are identified as COCs:

- Benzene, cadmium, chloroform, manganese, and PCBs for the construction worker
- PCBs, 2,3,7,8-tetrachlorodibenzo-p-dioxin toxic equivalent concentration (2,3,7,8-TCDD-TEQ), 4,4-DDD, 4,4-DDT, chlorobenzene, dieldrin and barium for the utility worker

Table 8-8 presents a summary of the potential cancer and non-cancer risks for the COCs for both the RME and MLE scenarios.

Site H Conclusions

Based on the results of the site-wide HHRA (ENSR, 2001), the following COCs have been identified for Site H:

- 2,3,7,8-TCDD-TEQ (ingestion, dermal contact, and inhalation of excavation air from soil and waste for the utility worker)
- 4,4-DDD (ingestion and dermal contact with soil and waste for the utility worker)
- 4,4-DDT (ingestion, dermal contact, and inhalation of excavation air from soil and waste for the utility worker)
- Barium (inhalation of excavation air from soil and waste for the utility worker)
- Benzene (inhalation of excavation air from groundwater and leachate for the construction worker)
- Cadmium (ingestion and dermal contact with leachate for the construction worker)
- Chlorobenzene (inhalation of excavation air from soil and waste for the utility worker)
- Chloroform (inhalation of excavation air from groundwater for the construction worker)
- Dieldrin (ingestion, dermal contact, and inhalation of excavation air from soil and waste for the utility worker)
- Manganese (inhalation of excavation air from subsurface soil for the construction worker)
- PCBs (ingestion and dermal contact with PCBs from subsurface soil for the construction worker and ingestion, dermal contact, and inhalation of excavation air from soil and waste for the utility worker)

RGOs were derived for the utility worker in Table 7-2 of the Utility Corridor HHRA (ENSR, 2008). As noted previously, RGOs were not developed for the construction worker scenario. Table 8-8 presents a summary of the potential cancer and non-cancer risks for the above listed COCs, as well as the RGOs, where applicable.

8.3.1.3 Site I

As shown in Table 8-2, all potential risks calculated for both the RME and MLE receptor scenarios in Site I are within or below the USEPA target risk range of 10^{-4} to 10^{-6}, with the exception of the RME outdoor industrial worker receptor. The potential risk for this receptor is $1.66x10^{-4}$. The potential risk is driven by potential incidental ingestion and dermal contact with 2,3,7,8-TCDD-TEQ in soils. Therefore, 2,3,7,8-TCDD-TEQ is identified as a COC for Site I soils.

As shown in Table 8-3, all potential HIs calculated for both the RME and MLE receptor scenarios for Site I are below the target HI of 1, with the exception of the following (HIs are noted):

- The RME outdoor industrial worker (2.15);
- The RME (48.1) and MLE (7.8) construction worker.

Because these HIs were calculated by summing all HIs for all pathways, a toxic endpoint analysis was conducted for each receptor in Appendix R of the site-wide HHRA (ENSR, 2001). Based on the toxic endpoint analyses, the following constituents are identified as COCs:

- PCBs in surface soil for the outdoor industrial worker and construction worker scenarios.
- Antimony, chlorobenzene, chloroform, 2-(2-Methyl-4-chlorophenoxy)propionic acid (MCPP), naphthalene, and PCBs for the construction worker.

Table 8-8 presents a summary of the potential cancer and non-cancer risks for the COCs for both the RME and MLE scenarios.

Site I Conclusions and Remedial Goals

Based on the results of the site-wide HHRA (ENSR, 2001), the following COCs have been identified for Site I:

- 2,3,7,8-TCDD-TEQ (ingestion and dermal contact with surface soil for the outdoor industrial worker)
- PCBs (ingestion and dermal contact with surface soil for the outdoor industrial worker and ingestion and dermal contact with surface soil, subsurface soil, and leachate for the construction worker)
- Antimony (ingestion and dermal contact with subsurface soil for the construction worker)
- Chlorobenzene (inhalation of excavation air from leachate for the construction worker)
- Chloroform (inhalation of excavation air from leachate for the construction worker)
- MCPP (ingestion and dermal contact with leachate for the construction worker)
- Naphthalene (inhalation of excavation air from leachate for the construction worker)

RGOs were derived for the outdoor industrial worker in the site-wide HHRA (ENSR, 2001). As noted previously, RGOs were not developed for the construction worker scenario. Table 8-8 presents a summary of the potential cancer and non-cancer risks for the above listed COCs, as well as the RGOs, where applicable.

8.3.1.4 Site I North and South

The HHRA evaluated Site I as one area. In the RI, Site I was divided into two areas, Site I North and Site I South, as discussed in Section 2.1.3 of this RI report. Summary statistics, including the frequency of detection, and minimum, mean, and maximum detected concentrations, were re-calculated for sampled media in Site I North and Site I South separately. These data summaries are presented in Section 3 of this RI report. An evaluation of Sites I North and South was performed to determine how the results of the HHRA may change based on the division of Site I into two distinct exposure areas.

The majority of the samples collected in Site I are located in Site I South, including 7 of 8 of the groundwater samples from the alluvial aquifer, 2 of the 4 source area surface soil samples, and 2 of the 4 source area subsurface soil samples. The exposure point concentrations (EPCs) evaluated for Site I in the HHRA are equal to the maximum detected constituent concentrations, which were all from samples within Site I South. Therefore, the risk results of the HHRA based on Site I South are expected to be consistent with those presented in the HHRA.

As discussed in Section 2.1.3 of this RI report, Site I North was an undisturbed tract at the time Site I South ceased operations. Therefore, an evaluation of the potential risk and HI associated with media at Site I North was performed for COCs identified in Site I in the HHRA to determine if they would be COCs in Site I North. In addition, subsurface soil samples collected as part of the DNAPL Characterization Study in 2004, following the completion and approval of the HHRA, were evaluated to determine if these data would result in the identification of COCs at Site I North. The evaluation of Site I North is presented in a technical memorandum in Appendix A. This evaluation concludes that there are no COCs identified in Site I North**.**

8.3.1.5 Site L

As shown in Table 8-2, all potential risks calculated for both the RME and MLE receptor scenarios in Site L are within or below the USEPA target risk range of 10^{-4} to 10^{-6}.

As shown in Table 8-3, all potential HIs calculated for both the RME and MLE receptor scenarios for Site L are below the target HI of 1, with the exception of the following (HIs are noted):

- The RME (5.21) and MLE (1.1) construction worker

Because these HIs were calculated by summing all HIs for all pathways, a toxic endpoint analysis was conducted for each receptor in Appendix R of the site-wide HHRA (ENSR, 2001). Based on the toxic endpoint analyses, PCBs in subsurface soil are identified as a COC based on the exposure point concentration of 500 mg/kg, which is the maximum detected concentration in the

historical dataset (Table 3-15). Detected PCB concentrations in subsurface soil range from 16 mg/kg to 500 mg/kg, with a mean concentration of 258 mg/kg. The HIs associated with the minimum detected, average, and maximum detected concentrations are 0.14, 2.2, and 4.2, respectively. Note that under the MLE scenario, the HI is below one on a target endpoint basis.

Table 8-8 presents a summary of the potential cancer and non-cancer risks for the COCs for both the RME and MLE scenarios.

Site L Conclusions and Remedial Goals

Based on the results of the site-wide HHRA (ENSR, 2001), the following COCs have been identified for Site L:

- PCBs (ingestion and dermal contact with subsurface soil for the construction worker)

As noted previously in Section 8.3, RGOs were not developed for the construction worker scenario. As discussed in Section 8.3, due to the range of RGOs that can be calculated, institutional controls rather than numerical RGOs may be more applicable to the construction worker scenario. Therefore, it is recommended that remedial alternatives addressing exposure to PCBs in subsurface soil at Site L by construction workers be considered in the Feasibility Study. Table 8-8 presents a summary of the potential cancer and non-cancer risks for the above listed COCs.

8.3.1.6 Site N

As shown in Table 8-2, all potential risks calculated for both the RME and MLE receptor scenarios in Site N are within or below the USEPA target risk range of 10^{-4} to 10^{-6}.

As shown in Table 8-3, all potential HIs calculated for both the RME and MLE receptor scenarios for Site N are below the target HI of 1.

Site N Conclusions

Based on the results of the site-wide HHRA (ENSR, 2001), no COCs have been identified for Site N.

8.3.2 Transects

Potential risks and hazards for the transects were evaluated in the site-wide HHRA (ENSR, 2001). No COPCs were identified in Transect 2. As indicated in Tables 8-4 and 8-5, there were no exceedances of the USEPA target risk range of 10^{-4} to 10^{-6} or the target HI of 1. Additionally, the lead modeling indicated that no adverse health effects are expected due to exposure to groundwater in well DW-MCDO (closest to Transect 1) for a construction worker or a residential child. Therefore, no COCs are identified for the transect areas.

8.3.3 Dead Creek, Borrow Pit Lake, and Site M

Potential risks and hazards for portions of Dead Creek Segment F and the Borrow Pit Lake not subject to the UAO issued in June 1999 and modified in May 2000 were evaluated in the site-wide HHRA (ENSR, 2001). In August 2001, the UAO was amended to include sediments in these areas of Dead Creek Segment F and the Borrow Pit Lake and the sediment removal within these areas was completed in February 2002. Potential risks and hazards for Dead Creek Segments B, C, D, E, and portions of F and Site M were evaluated in the Creek Bottom Soils HHRA (ENSR, 2006). No COPCs were identified in Creek Segment C. As indicated in Table 8-6, there were no exceedances of the USEPA target risk range of 10^{-4} to 10^{-6}. In addition, potential risks to the recreational fisherman and the recreational teen, which are below and within USEPA's target risk range of 10^{-4} to 10^{-6}, respectively, as presented on Table 8-6, were estimated based on sediment data collected prior to the sediment removal action conducted in 2000-2001 for the purposes of addressing ecological risk. As a result of the sediment removal action, potential risks to the recreational fisherman and recreational teen are expected to be lower than those estimated in the HHRA (ENSR, 2001).

As indicated in Table 8-7, potential HIs are below 1 for all areas except Creek Segment B. The total HI for both the recreational child and the construction worker exceeds 1 under the RME scenario.

For the construction worker, the HI is below 1 on a target endpoint basis and therefore no COCs are identified for the construction worker scenario.

For the recreational child, the HI exceeds 1 on a target endpoint basis for PCBs. The samples in Creek Segment B driving the Total PCB exceedance are CBS-CSB-T0-C and CBS-CSB-T3-E. Both of these sampling locations were excavated as part of the creek bottom soil removal action underway at the time the Creek Bottom Soils HHRA (ENSR, 2006) was being conducted. CSB-TO-C was excavated to a depth of two (2) feet and CSB-T3-E was excavated to a depth of five (5) feet. In order to further evaluate the potential HI associated with Total PCBs in Creek Segment B, the HI was re-calculated using samples remaining after excavation as well as the samples collected in December 2005 as part of the verification sampling conducted after the excavation, as described in ENSR, 2006. This results in an HI for PCBs of 0.009, well below one. Therefore, the HI using data remaining after excavation is below one, and there is no longer a potential HI exceedance for PCBs in Creek Segment B. In addition, an armored, impermeable liner was installed throughout the entire length of Creek Segment B in 2008. Therefore, there is no longer a potential exposure PCBs in Creek Segment B, and no COCs are identified.

8.3.4 Summary

In summary, risks and hazards were within or below USEPA's target risk range of 10^{-4} to 10^{-6} and a target hazard index of one on a target endpoint basis and, therefore, no COCs were identified for the following:

- Site N and Site M

- Residential Transects
- Dead Creek Segments and Borrow Pit Lake

Some risks or hazards exceeded USEPA's target risk range of 10^{-4} to 10^{-6} and/or a target hazard index of one on a target endpoint basis and, therefore, COCs were identified for the following Sites, as shown in Table 8-8:

- Site G – construction worker receptor
- Site H – utility worker and construction worker receptors
- Site I – outdoor industrial worker and construction worker receptors
- Site L – construction worker receptor

Remedial Goal Options (RGOs) were derived for the utility worker receptor for Site H and the outdoor industrial worker receptor for Site I.

RGOs were not derived for the construction worker scenario, as noted in the beginning of Section 8.3. For this receptor, institutional controls rather than numerical RGOs may be more applicable. However, construction worker COCs should be considered when making remedial decisions.

8.4 References

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AECOM. 2009b. Sauget Area 1 EE/CA and RI/FS Addendum – Vapor Intrusion Human Health Risk Assessment Technical Memorandum – Evaluation of Chemical Use at the Wiese Building. January 2009. USEPA Approved (August 2009).

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